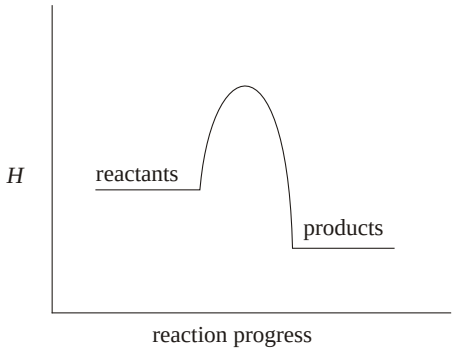
T05D10 – SL Energetics Exam

Name……

1. According to the enthalpy level diagram to the right, what is the sign for Δ*H* and what term is used to refer to the reaction?



	Δ*H*	reaction
A.	positive	endothermic
B.	negative	exothermic
C.	positive	exothermic
D.	negative	endothermic

2. Which statement is correct for an endothermic reaction?

A. The products are more stable than the reactants and Δ*H* is positive.
B. The products are less stable than the reactants and Δ*H* is negative.
C. The reactants are more stable than the products and Δ*H* is positive.
D. The reactants are less stable than the products and Δ*H* is negative.

3. Which statements are correct for all exothermic reactions?

I. The enthalpy of the products is less than the enthalpy of the reactants.
II. The sign of Δ*H* is negative.
III. The reaction is rapid at room temperature.

A. I and II only
B. I and III only
C. II and III only
D. I, II and III

4. Using the equations below:

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H^{\ominus} = -394$ kJ mol^{-1}

$Mn(s) + O_2(g) \rightarrow MnO_2(s)$ $\Delta H^{\ominus} = -520$ kJ mol^{-1}

What is Δ*H*, in kJ, for the following reaction?

$$MnO_2(s) + C(s) \rightarrow Mn(s) + CO_2(g)$$

A. 914
B. 126
C. –126
D. –914

5. When 40 joules of heat are added to a sample of solid H_2O at –16.0°C the temperature increases to –8.0°C. What is the mass of the solid H_2O sample?

[Specific heat capacity of $H_2O(s) = 2.0$ J g^{-1}K^{-1}]

A. 2.5 g
B. 5.0 g
C. 10 g
D. 160 g

6. For the reaction $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ the bond enthalpies (in kJ mol^{-1}) are

H–H	*x*
O=O	*y*
O–H	*z*

Which calculation will give the value, in kJ mol^{-1}, of $\Delta H^{\ominus}$ for the reaction?

A. $2x + y - 2z$
B. $4z - 2x - y$
C. $2x + y - 4z$
D. $2z - 2x - y$

7. Which statement is correct for an endothermic reaction?

A. Bonds in the products are stronger than the bonds in the reactants.
B. Bonds in the reactants are stronger than the bonds in the products.
C. The enthalpy of the products is less than that of the reactants.
D. The reaction is spontaneous at low temperatures but becomes non-spontaneous at high temperatures.

8. Consider the following reactions.

$S(s) + 1\frac{1}{2} O_2(g) \rightarrow SO_3(g)$ $\Delta H^{\ominus} = -395$ kJ mol^{-1}

$SO_2(s) + \frac{1}{2} O_2(g) \rightarrow SO_3(g)$ $\Delta H^{\ominus} = -98$ kJ mol^{-1}

What is the $\Delta H^{\ominus}$ value (in kJ mol^{-1}) for the following reaction?

$S(s) + O_2(g) \rightarrow SO_2(g)$

A. –297
B. +297
C. – 493
D. +493

9. Consider the specific heat capacity of the following metals.

Metal	Specific heat capacity / J kg^{-1} K^{-1}
Cu	385
Ag	234
Au	130
Pt	134

Which metal will show the greatest temperature increase if 50 J of heat is supplied to a 0.001 kg sample of each metal at the same initial temperature?

A. Cu
B. Ag
C. Au
D. Pt

10. The equations and enthalpy changes for two reactions used in the manufacture of sulfuric acid are:

$S(s) O_2(g) \rightarrow SO_2(g)$ $\Delta H^{\ominus} = -300$ kJ

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ $\Delta H^{\ominus} = -200$ kJ

What is the enthalpy change, in kJ, for the reaction below?

$2S(s) + 3O_2(g) \rightarrow 2SO_3(g)$

A. –100
B. –400
C. –500
D. –800

11. How much energy, in joules, is required to increase the temperature of 2.0 g of aluminum from 25 to 30°C? (Specific heat of Al = 0.90 J g^{-1} K^{-1}).

A. 0.36
B. 4.5
C. 9.0
D. 54

12. An equation for a reaction in which hydrogen is formed is

$CH_4 + H_2O \rightarrow 3H_2 + CO$ $\Delta H^{\ominus} = +210$ kJ

Which energy change occurs when 1 mol of hydrogen is formed in this reaction?

A. 70 kJ of energy are absorbed from the surroundings.
B. 70 kJ of energy are released to the surroundings.
C. 210 kJ of energy are absorbed from the surroundings.
D. 210 kJ of energy are released to the surroundings.

13. The average bond enthalpy for the C—H bond is 412 kJ mol^{-1}. Which process has an enthalpy change closest to this value?

A. $CH_4(g) \rightarrow C(s) + 4H(g)$
B. $CH_4(g) \rightarrow CH_3(g) + H(g)$
C. $CH_4(g) \rightarrow C(s) + 2H_2(g)$
D. $CH_4(g) \rightarrow C(g) + 2H_2(g)$

14. A simple calorimeter was used to determine the enthalpy of combustion of ethanol. The experimental value obtained was –920 kJ mol^{-1}. The Data Booklet value is –1371 kJ mol^{-1}. Which of the following best explains the difference between the two values?

A. incomplete combustion of the fuel
B. poor ventilation in the laboratory
C. heat loss to the surroundings
D. inaccurate temperature measurements

15. The mass *m* (in g) of a substance of specific heat capacity *c* (in J g^{-1} K^{-1}) increases by *t*℃. What is the heat change in J?

A. mct
B. $mc(t + 273)$
C. $\frac{mct}{1000}$
D. $\frac{mc(t + 273)}{1000}$

16. Which statements are correct for an endothermic reaction?

I. The system absorbs heat.
II. The enthalpy change is positive.
III. The bond enthalpy total for the reactants is greater than for the products.

A. I and II only
B. I and III only
C. II and III only
D. I, II and III

17. Consider the following equations.

$Mg(s) + \frac{1}{2} O_2(g) \rightarrow MgO(s) \quad \Delta H^{\ominus} = -602$ kJ

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g) \quad \Delta H^{\ominus} = -242$ kJ

What is the Δ*H*° value (in kJ) for the following reaction?

$MgO(s) + H_2(g) \rightarrow Mg(s) + H_2O(g)$

A. –844
B. –360
C. +360
D. +844

18. When the solids $Ba(OH)_2$ and NH_4SCN are mixed, a solution is produced and the temperature drops.

$Ba(OH)_2(s) + 2NH_4SCN(s) \rightarrow Ba(SCN)_2(aq) + 2NH_3(g) + 2H_2O(l)$

Which statement about the energetics of this reaction is correct?

A. The reaction is endothermic and Δ*H* is negative.
B. The reaction is endothermic and Δ*H* is positive.
C. The reaction is exothermic and Δ*H* is negative.
D. The reaction is exothermic and Δ*H* is positive.

19. Using the equations below:

$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H = -390$ kJ

$Mn(s) + O_2(g) \rightarrow MnO_2(s) \qquad \Delta H = -520$ kJ

what is Δ*H* (in kJ) for the following reaction?

$MnO_2(s) + C(s) \rightarrow Mn(s) + CO_2(g)$

A. 910
B. 130
C. –130
D. –910

20. For which of the following is the sign of the enthalpy change different from the other three?

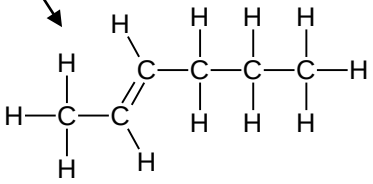
A. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
B. $Na(g) \rightarrow Na^+(g) + e^-$
C. $CO_2(s) \rightarrow CO_2(g)$
D. $2Cl(g) \rightarrow Cl_2(g)$

21. Hex-2-ene gas, burns in oxygen to produce carbon dioxide and water vapor according to the following equation.

$C_6H_{12} + 9O_2 \rightarrow 6CO_2 + 6H_2O$

(a) Use the data below to calculate (SHOW WORK) the value of $\Delta H^{\ominus}$ for the combustion hex-2-ene.

Bond	C-C	C=C	C-H	O=O	C=O	O–H
Average bond enthalpy / kJ mol^{-1}	348	612	412	496	743	463



(3)

(b) State and explain whether the reaction above is endothermic or exothermic.

(1)
(Total 4 marks)

22. Two reactions occurring in the manufacture of sulfuric acid are shown below:

reaction (I) $S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H^{\ominus} = -297$ kJ

reaction (II) $SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$ $\Delta H^{\ominus} = -92$ kJ

(i) State the name of the term $\Delta H^{\ominus}$. State, with a reason, whether reaction (I) would be accompanied by a decrease or increase in temperature.

(3)

(ii) At room temperature sulfur trioxide, SO_3, is a solid. Deduce, with a reason, whether the $\Delta H^{\ominus}$ value would be more negative or less negative if $SO_3(s)$ instead of $SO_3(g)$ were formed in reaction II.

(2)

(iii) Deduce the $\Delta H^{\ominus}$ value of this reaction:

$$S(s) + 1\tfrac{1}{2} O_2(g) \rightarrow SO_3(g)$$

(1)
(Total 6 marks)

23. Given the following data:

$C(s) + F_2(g) \rightarrow CF_4(g)$; $\Delta H_1 = -680$ kJ mol^{-1}

$F_2(g) \rightarrow 2F(g)$; $\Delta H_2 = +158$ kJ mol^{-1}

$C(s) \rightarrow C(g)$; $\Delta H_3 = +715$ kJ mol^{-1}

calculate the average bond enthalpy (in kJ mol^{-1}) for the C—F bond.

(Total 4 marks)

24. (i) Define the term *average bond enthalpy*.

(3)

(ii) Explain why Br_2 is not suitable as an example to illustrate the term *average bond enthalpy*.

(1)

(iii) Using values from Table 10 of the Data Booklet, calculate the enthalpy change for the following reaction:

$$CH_4(g) + Br_2(g) \rightarrow CH_3Br(g) + HBr(g)$$

(3)

(iv) Sketch an enthalpy level diagram for the reaction in part (iii).

(2)

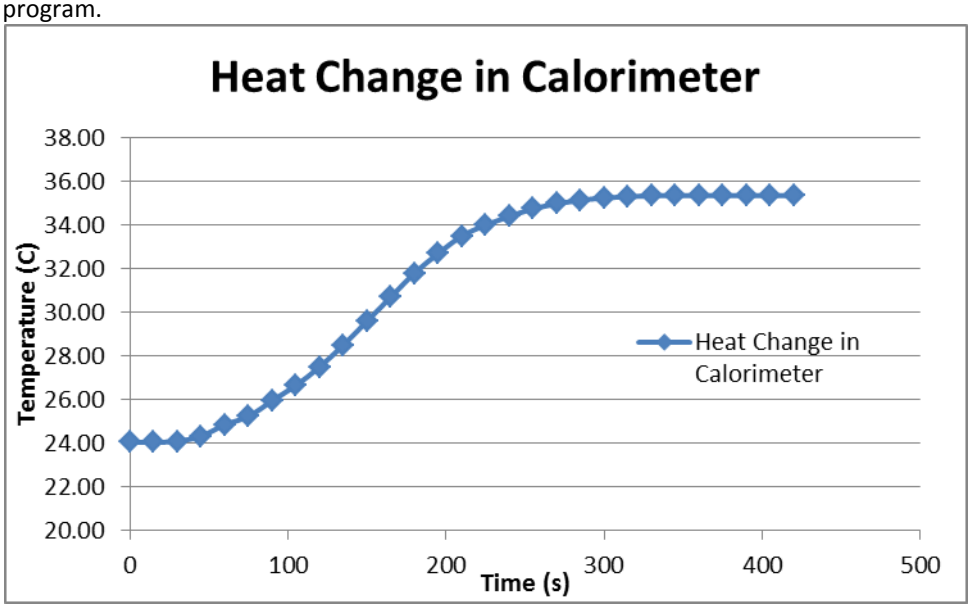
(v) Without carrying out a calculation, suggest, with a reason, how the enthalpy change for the following reaction compares with that of the reaction in part (iii):

$$CH_3Br(g) + Br_2(g) \rightarrow CH_2Br_2(g) + HBr(g)$$

(2)

(Total 11 marks)

25. The data below is from an experiment used to measure the enthalpy change for the combustion of 1 mole of glucose (simple monosaccharide), $C_6H_{12}O_6(s)$. The time-temperature data was taken from a data-logging software program.



Mass of sample of glucose, *m* = 0.254 g
Mass of water in calorimeter m = 75.000 g

(a) Calculate Δ*T*, for the water, surrounding the chamber in the calorimeter.

(1)

(b) Determine the amount, in moles, of glucose.

(1)

(c) (i) Calculate the enthalpy change (kJ mol^{-1}) for the combustion of 1 mole of glucose.

(2)

(ii) Using Table 12 of the Data Booklet, calculate the percentage experimental error based on the data used in this experiment.

(1)

(d) A hypothesis is suggested that TNT, 2-methyl-1,3,5-trinitrobenzene, is a powerful explosive because it has:

- a large enthalpy of combustion
- a high reaction rate
- a large volume of gas generated upon combustion

	Equation for combustion	**Relative rate of combustion**	**Enthalpy of combustion / kJ mol^{-1}**
Glucose	$C_6H_{12}O_6(s) + 12O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$	Low	
TNT	$2C_7H_5N_3O_6(s) \rightarrow 7CO(g) + 7C(s) + 5H_2O(g) + 3N_2(g)$	High	3406

Use your answer in part (c)(i) and the following data to evaluate this hypothesis:

**FYI, your answer may be different than on the review as your results are different. Read each statement!!

(3)
(Total 8 marks)